The examiner agreed and issued the 10/08 Office action to which the instant paper replies. Applicant thanks the examiner for withdrawing the finality of the 9/23 action.

Claims 1-11 stand rejected for alleged obviousness from VanVucht in view of Kitagawa. This rejection is traversed.

As tacitly admitted in the Office action, VanVucht does not teach subtracting backscattered-particle data obtained from a region of a substrate lacking an alignment mark from backscattered-particle data obtained from an alignment mark on the substrate. In addition, as discussed in the previous response of 6/19/02, VanVucht provides no teaching or suggestion whatsoever of either the problem described in the specification on page 3, lines 8-19 or how to solve such a problem (emphasis added):

> In the apparatus of FIG. 3(A), whenever the specimen 7 is a silicon wafer having well-defined crystal properties, the BSE signal waveform that is obtained includes components derived from the alignment mark 7a and from the crystal properties of the specimen 7 itself. These signals are detected simultaneously, and thus both contribute substantially to the BSE signal waveform.
>
> For example, if the electron beam incident on a crystalline silicon wafer 7 has an energy of approximately 100 keV, then changes in signal amplitude originating from the crystalline properties of the wafer material will be nearly equal to changes in the amplitude of the BSE signal from an alignment mark formed by channels in the wafer surface. <u>The resulting lack of differentiation in the BSE signal produced by the alignment mark versus by the wafer surface causes a significant reduction in the accuracy with which the position of the alignment mark can be detected.</u>

VanVucht, in contrast, is directed to solving the following problem (col. 1, lines 40-47; emphasis added):

> In the cited Patent Specification [EP 233816] the relative position of the object with respect to the electron beam system is known. <u>A problem is encountered, however, in the case of a shift of the relative position of the object with respect to the electron beam system.</u> The invention has for its <u>object to provide an efficient method of determining a relative position of a specimen provided with a marker with respect to an electron beam system</u>.

Hence, it is clear that the method disclosed in VanVucht is directed to a different problem than the subject claims.

According to VanVucht, if a shift occurs in the location of an origin on the specimen relative to an origin of the electron-beam system, the method described in EP '816 does not work well. VanVucht solves this problem by scanning a marker pattern defined topologically or by a heavy metal on the substrate. Col. 1, line 68 to col. 2, line 13. From scanning of the marker pattern, a corresponding signal-intensity distribution I(x, y) is obtained. Col. 1, lines 12-18. To obtain an estimate of the amount of shift that has occurred in these origins relative to each other, <u>stored data concerning an intensity distribution B(x, y) of a predetermined test pattern</u> is recalled and compared with the measured intensity distribution I(x, y) from the marker. Col. 1, lines 35-39. The data concerning B(x, y) are assumed to be constant and are not measured from the actual specimen. Col. 2, lines 59-66 and col. 3, lines 28-36. Thus, <u>essentially, a constant is subtracted from data obtained from an actual marker on the specimen so as to obtain data concerning differences between the two patterns</u> (i.e., the marker pattern and the predetermined test pattern). <u>This is not what is currently claimed and does not lead to what is currently claimed.</u>

This method in VanVucht would not solve the problem addressed by the instant claim 1 because: (a) the VanVucht data B(x, y) pertain to a predetermined test pattern, not to an area of the specimen surface lacking a mark; (b) the data B(x, y) that are subtracted in VanVucht are not understood to reflect changes in signal amplitude originating from the crystal-lattice structure of the substrate material itself; and (c) the data B(x, y) subtracted in VanVucht are not measured data but rather are stored data assumed to be constant. Hence, again, VanVucht does not teach or suggest what is currently claimed.

VanVucht mentions that, "[w]hen the specimen is irradiated by an electron beam, the number of electrons dispersed by the specimen will deviate from the number of electrons dispersed by the marker. The marker can thus be distinguished from the specimen." Col. 1, lines 61-65. However, in so stating, VanVucht does <u>not</u> disclose subtracting backscattered-particle data obtained from a region of the crystal-lattice surface lacking an alignment mark from backscattered-particle data obtained from an alignment mark on said surface. Rather, VanVucht is understood merely to explain that electrons dispersed by the marker are sufficiently distinctive to allow detection of those electrons. Hence, again, VanVucht does not teach or suggest what is currently claimed.

In claim 1, in contrast to VanVucht, data for a region of the substrate surface having a crystal-lattice orientation are subtracted from data from an actual mark on said surface. The data for the region of the substrate surface lacking the mark (but nevertheless having the crystal-lattice orientation) provide a background signal that, when subtracted from data obtained by backscattered charged particles from the alignment mark, removes a type of "noise" (generated by impingement of the beam from the crystal-lattice structure of the substrate surface) that otherwise would have a substantial adverse effect on the signal from the alignment mark. I.e., a backscattered-particle signal from the alignment mark has two components: one component pertains to the scattering properties of the mark itself, and the other component pertains to the crystal-lattice property of the substrate. To separate these two components, a portion of the substrate surface lacking the mark (but having the crystal-lattice orientation) is scanned (producing a first signal), the mark itself is scanned (producing a second signal), and the first signal is subtracted from the second signal. VanVucht is completely silent on this source of noise and in fact ignores it.

In VanVucht, in contrast, noise is removed by changing the integration time of multiple integrations of the signal, depending upon the required accuracy of the signal. See col. 3, line 60 to col. 4, line 11. Hence, VanVucht uses an entirely different approach to reducing noise, and reduces an entirely different type of noise, than recited in or addressed by claim 1.

Furthermore, in VanVucht, the intensity of electrons dispersed from an alignment mark is measured without any attention given to the contribution, to the measured intensity, of the crystalline structure of the substrate. In claim 1, in contrast, the important contribution of charged particles, backscattered from the crystal-lattice surface of the substrate, on the signal obtained by charged particles backscattered from an alignment mark on said surface is recognized and accounted for by performing step (c) in the claim. This step is not taught or suggested in VanVucht, which is absolutely silent on unwanted contributions to a signal from backscattering from a crystal-lattice structure of the substrate, and absolutely silent on scanning a portion of a crystal-latticed surface of the substrate that lacks a mark.

In view of the above, claim 1 and its dependents are neither anticipated by nor obvious from VanVucht.

Kitagawa is cited for its alleged disclosure of subtracting a background signal from a backscatter signal from a feature. Despite the statements in the Office action, Kitagawa does not

cure any of the deficiencies of VanVucht. Kitagawa is directed to methods for evaluating the resolving power of an electron microscope. The specimen has a multilayer thin film prepared from materials that are significantly different in atomic number. Col. 1, line 52 to col. 2, line 3; col. 2, lines 22-28 and 42-46; col. 4, lines 37-55. An electron-beam profile is obtained by differentiating data corresponding to step signals attained during scanning of the beam over a cross-section ("cleft") of the specimen surface. Col. 2, lines 3-14; col. 3, lines 28-36; col. 4, lines 44-55. Thus, the irradiated surface is not a surface having a crystal-lattice structure and there is no recognition or attempt in Kitagawa of removing any possible influence of this nature on the signal. Furthermore, since the thickness of individual layers of the Kitagawa substrate is in the range of several nm (col. 5, lines 58-64), any change in backscattering from one side of the cleft to the other is very small and hence unimportant to the Kitagawa method. Rather, it is sufficient in Kitagawa to regard background levels of backscattered electrons as constant during measurements of resolution by application of the Rayleigh limit. No separate measurement of backscattered electrons from a crystal-lattice surface of the substrate is required, taught, or suggested. Also not suggested in Kitagawa is any possible influence on background backscattering due to interactions of the beam with a crystal-lattice surface of the substrate, or whether such influence is worthy of consideration. Hence, there is no teaching or suggestion whatsoever in this reference of fulfilling the deficiencies of VanVucht.

Therefore, claim 1 and its dependents are not obvious from any conceivable combination of VanVucht and Kitagawa.

The examiner contended in the Office action, "One of ordinary skill in the art would have been motivated to have combined the teaching from Kitagawa with the process taught by VanVucht because it is implicit in the teaching of a contrast which is a difference between the signals of the specimen and the marker taught by VanVucht that the difference between the signal from the alignment mark and the background would be obtained by subtracting the background from the signal from the alignment mark." The incorrectness of this contention is readily discernible from the foregoing discussion. As discussed above, VanVucht does not teach "a contrast which is a difference between the signals of the specimen and the marker." Also not taught by VanVucht or by Kitagawa is the contended "difference between the signal from the alignment mark" and the particular type of background addressed by claim 1 and its dependents.

Furthermore, much of the examiner's contention is based on hindsight obtained from Applicant's disclosure, which is not a proper basis for an obviousness rejection.

The examiner also contended that "although the purpose of the method disclosed by VanVucht may be different from applicant's method, the combination of VanVucht with Kitagawa shows that the step of subtraction of a signal from the background from the signal from the feature being detected is a step that is known in the prior art and that the method disclosed by VanVucht encompasses this step." In view of the amendments herein and the discussion above, the incorrectness of this contention is readily apparent.

In view of the allowability of claims 1-7, as discussed above, and in view of arguments previously submitted, the allowability of claims 8-12 (and of claim 13) is readily apparent.

The claims are in condition for allowance, and action to such end is requested.

Applicant has a right to an interview at this stage of prosecution. If any issues remain unresolved after consideration of the contents of this paper, the examiner is requested to contact the undersigned to schedule a telephonic interview. Any inaction by the examiner to make such contact, followed by issuance of a final action, will be regarded as an acquiescence by the examiner to grant an interview as a matter of right after the final action.

Respectfully submitted,

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Marked-up Version of Amended Claims
Pursuant to 37 C.F.R. §§ 1.121(b)-(c)

<u>In the claims:</u>

1. (Amended) In a method for performing charged-particle-beam (CPB) microlithography of a specimen <u>of which a surface has a crystal-lattice orientation, and an alignment mark is formed on the surface</u>, a method for detecting a position of **[an]**<u>the</u> alignment mark**[on the specimen]**, comprising:

(a) irradiating a charged particle beam onto an area of the specimen **[lacking an]**<u>surface having the crystal-lattice orientation but at which the</u> alignment mark <u>is not present</u>, and detecting backscattered charged particles propagating from the irradiated area, so as to obtain a first backscattered-particle signal;

(b) irradiating the charged particle beam onto the alignment mark, and detecting backscattered charged particles propagating from the irradiated alignment mark, so as to obtain a second backscattered-particle signal;

(c) subtracting the first backscattered-particle signal from the second backscattered-particle signal to obtain a difference signal; and

(d) determining the alignment-mark position from the difference signal.

2. (Amended) The method of claim 1, wherein step (a) is performed by scanning the charged particle beam across a smooth planar region of **[a]**<u>the</u> surface of the specimen.

4. (Amended) The method of claim 1, wherein:

[the specimen has a crystal-orientation plane;]

the first backscattered-particle signal is obtained by scanning the charged particle beam across a smooth planar region of **[a]**<u>the</u> surface of the specimen **[representing a]**<u>that represents the</u> crystal-orientation plane**[of the specimen]**; and

in step (c), the subtraction of the first backscattered-particle signal from the second backscattered-particle signal removes data, concerning the crystal-orientation **[of the substrate]**<u>plane</u>, from the difference signal that otherwise would obfuscate data in the difference signal pertaining to the alignment mark.

6. (Amended) In a charged-particle-beam (CPB) microlithography apparatus including a CPB source that produces a charged particle beam, a CPB-optical system through which the charged particle beam passes from the CPB source to a substrate of which a surface has a crystal-lattice orientation and includes an alignment mark formed on the surface, and a substrate stage on which the substrate is placed for exposure by the charged particle beam, a device for measuring an alignment of the substrate, the device comprising:

a deflector situated and configured to deflect the charged particle beam to cause the beam to irradiate a predetermined location on the surface of the substrate mounted on the substrate stage, so as to cause the location to produce backscattered particles;

a backscattered-particle detector situated and configured to detect backscattered charged particles produced by the location on the substrate as the location is irradiated by the charged particle beam;

a controller connected to the deflector and the backscattered-particle detector, the controller being configured to (i) energize the deflector in a manner causing the deflector to irradiate the beam on a first location on the **[substrate]**surface lacking an alignment mark, thereby producing a background backscattered-particle signal including data generated by backscatter from features associated with the crystal-lattice orientation; (ii) energize the deflector in a manner causing the deflector to irradiate the beam on **[a second location on the substrate in which an]**the alignment mark**[is formed]**, thereby producing an alignment-mark backscattered-particle signal; (iii) calculate a difference signal by subtracting the background signal from the alignment-mark signal; and (iv) determine the position of the alignment mark from the difference signal.

Please add the following new claim:

13. (New) The method of claim 1, wherein the first backscattered-particle signal includes data produced by scanning the charged particle beam across one or more Kikuchi lines on the surface.